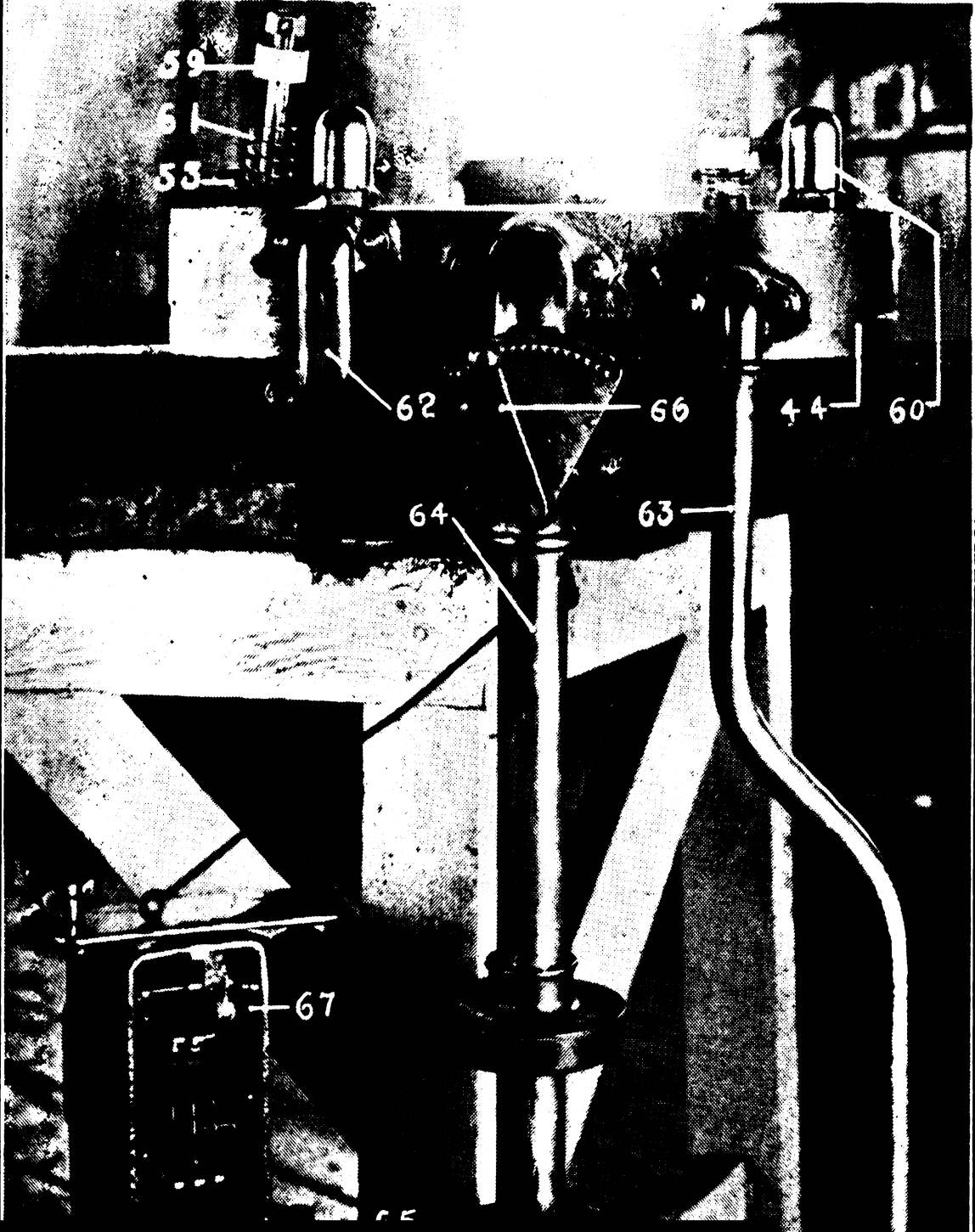

Artillery Notes...

Coast Artillery School (U.S.)

ARTILLERY NOTES
No. 39

Gasoline Engines in Distribution-Box Boats and Mine-Yawls

PUBLISHED UNDER SUPERVISION OF THE
SCHOOL BOARD
COAST ARTILLERY SCHOOL

FORT MONROE, VIRGINIA
U.S. COAST ARTILLERY SCHOOL PRESS
1915

THIS NOTE WAS PREPARED BY

CAPTAIN JAMES B. TAYLOR,

COAST ARTILLERY CORPS

GASOLINE ENGINES IN DISTRIBUTION-BOX BOATS AND MINE YAWLS

GENERAL FEATURES OF INTERNAL COMBUSTION ENGINES

There are two general types of internal combustion engines, known as the four-cycle engine and the two-cycle engine.

In the four-cycle engine there are two valves, one of which is the inlet valve, for admitting the mixture of air and gasoline to the cylinder, and the other is the exhaust valve, for allowing the escape of the burned gases from the cylinder to the exhaust pipe. The *inlet* valve may be operated by a cam shaft, or it may be operated by suction, as in the Standard engine. The *exhaust* valve is always operated by a cam shaft. The cam shaft, whether it operates one or both of the valves, must rotate at one-half crank-shaft speed. This relation is obtained by driving the cam shaft with pinions. The pinion keyed to the cam shaft has twice as many teeth as the pinion which is keyed to the crank shaft. It is also necessary to make the pinions mesh so that the position of the cams bears a definite relation to the position of the cranks.

There are four events, requiring four strokes of the piston or two revolutions of the crank shaft, which make one complete cycle of operations. These are: (1) the suction stroke, which draws in a charge of air and gasoline; (2) the compression stroke, during which the volume of the charge is greatly reduced and the pressure increased by the piston moving toward the head end of the cylinder; (3) the expansion stroke, or the power stroke, caused by the firing of the mixture at about the time of highest compression; and (4) the exhaust stroke, during which the burned gases leave the cylinder. The inlet valve opens soon after the piston starts on its travel from the head end of the cylinder toward the crank end and closes when the piston starts toward the head end on compression stroke. During compression and power strokes both valves are closed. The exhaust valve opens just before the piston reaches the end of its travel on the power stroke, and closes just after the

piston has completed its travel toward its head end. Immediately after the exhaust valve closes, the inlet valve opens.

In the two-cycle engine there are no valves. The engine may be two-port or three-port. The crank case must be air-tight. A two-port engine requires a check valve between the crank case and the carburetor, as in the Lathrop engine. A three-port engine, such as the Bridgeport, needs no check valve.

The four events described above for a four-cycle engine are, in the two-cycle engine, completed in two strokes, or one revolution of the crank shaft. Assume that the piston is at the head end of the cylinder with a charge of air and gasoline compressed above it. A spark occurs at the igniter points and the piston is forced downward on a power, or expansion, stroke. At the same time a charge of air and gasoline, which had entered the crank case on the preceding upward stroke, is compressed. When the piston is a short distance from the end of its power stroke, the exhaust port, which is an opening in the wall of the cylinder, is uncovered by the piston and the burned gases allowed to escape. Just after the exhaust port is uncovered, the inlet port is uncovered by the piston. The inlet port is connected by a passage in the cylinder wall with the crank case. The charge which had been compressed in the crank case can now rush into the cylinder through the inlet port. A projection on the piston, called a deflector plate, prevents the charge from blowing across the top of the piston and out through the exhaust port. The piston starts on its upward compression stroke, closing the inlet and then the exhaust port. As the piston moves toward the head end of the cylinder a vacuum is formed in the crank case, which draws air and gasoline from the carburetor through the check valve into the crank case. When the piston starts toward the crank end, the check valve closes and holds the mixture in the crank case where it is compressed, so that there is sufficient pressure to force the charge into the cylinder when the inlet port is uncovered.

In the three-port two-cycle engine the carburetor is connected with a port which is uncovered when the piston nearly reaches the head end of its stroke. When this port is uncovered, a charge is drawn into the crank case. As the piston starts on a power stroke the port connecting with the carburetor is covered and the charge is compressed in the crank case.

THE STANDARD ENGINE

This engine is built by the Standard Motor Construction Co., Jersey City, N. J. It is the kind of engine which is installed in the distribution-box boats. It is two-cylinder, four-cycle, 6-inch bore by 8-inch stroke, and is rated at 16 to 18 horsepower at a speed of 360 revolutions per minute.

Cylinders

The cylinders, E¹e1 (Fig. 7) and 43 (Figs. 3 and 4), are cast en bloc and are bolted to the base by 6 bolts. The cylinder heads, E¹e3 (Fig. 7) and 44 (Figs. 3 and 4) are also cast in one piece and are secured to the cylinder by twelve bolts. Both cylinder and head are double walled to provide the necessary water space around the combustion chamber.

Base

The base or crank case consists of two halves; the lower half, or sub-base, 13 (Fig. 1), forms a basin serving to enclose the cranks and retain the surplus oil and is flanged to provide means for bolting the engine down to the boat frame.

The upper half or intermediate base, E¹e4 (Fig. 7) and 20 (Figs. 2 and 3), forms a support for the cylinders and encloses cranks, cam shaft, etc.

Pistons

Each piston is provided with four piston rings, Ee8 (Fig. 7) and 7 (Fig. 1), three above and one below the wrist-pin bearing. On the side of the piston above the wrist-pin are oil grooves for the proper distribution of the oil supplied by the pipe from the mechanical oiler.

The piston is bored transversely to receive the hollow wrist-pin, Ee7 (Fig. 7) and 8 (Fig. 1), which communicates the motion of the piston through the connecting rod, Ee13 (Fig. 7) and 4 (Figs. 1 and 3) and crank 2 (Fig. 1) to the main journal 10 (Fig. 1).

Valves

The exhaust valves, Ee29 (Fig. 7) and 49 (Fig. 4), are of the mechanically operated poppet type and are normally held

against the valve seats by the springs, Ee33 (Fig. 7) and 50 (Fig. 4). The lower end of the exhaust valve stem, Ee30 (Fig. 7), bears against the exhaust valve lifter, Ee25 (Fig. 7) and 23 (Fig. 2), which is rotated around its axis, Ee37 (Fig. 7) and 26 (Fig. 2), by the exhaust cam, Ee24 (Fig. 7) and 22 (Fig. 2), on the cam shaft.

The inlet valves, Ee43 (Fig. 7) and 53 (Figs. 4 and 5), are of the automatic type and are provided with a dash-pot for reducing vibration and noise. The valve is held against its seat by means of a spring, Ee47 (Fig. 7) and 61 (Fig. 5). At the upper end of the valve stem, Ee42 (Fig. 7), is a piston, Ee44 (Fig. 7) and 59 (Fig. 5), which works in a brass cylinder, Ee45 (Fig. 7) and 60 (Fig. 5). Air caught in the upper end of the cylinder prevents the violent closing of the valve.

Intake

Air is taken into the heater pipe around the exhaust, through the space between the double walls of the crank case into the vaporizer. Here it receives a charge of gasoline, which is drawn up with it. The mixture of the gasoline vapor and air is completed in the intake pipe, and the mixture passes into the intake space in each cylinder head. On the suction stroke, the suction causes the inlet valve to open and a charge of the explosive gases is drawn into the cylinder. Taking the air from around the heater pipe, insures good evaporation of the gasoline after the engine has started, even in very cold weather.

Vaporizer

The vaporizer, or carburetor, is of the float feed type. It consists of a bowl, surrounding the intake pipe which contains a float and two valves, the float or cut-off valve, and the gasoline needle valve. As shown in Fig. 8, the float lever is pivoted at the bolt under the cut-off valve (EV51) and is attached to the float (EV49). The cut-off valve is secured to the float lever so that it is raised when the float rises. The cut-off valve seat consists of a threaded plug with a square head, the bottom being bored out axially to form a chamber, and a groove being cut around the plug at the height of the supply pipe. A hole is drilled radially, connecting this groove, or channel, with the axial hole. It is evident that, without the channel, if the radial hole did not register with the supply hole, the gasoline would be cut off. The construction of the

needle valve is clearly shown, EV53 (Fig. 8). The passage from the valve seat is connected with five spray tubes in the intake. The top edges of the latter are just above the level of the gasoline in the bowl, so that, even if the needle valve is wide open, no gasoline will flow down the intake pipe and leak out on the base and floor.

When the vaporizer bowl is empty, the float is at its lowest position and the cut-off valve is open. Gasoline enters through the supply pipe, flows around the channel to the plug hole, to the center chamber, through the valve to the lower chamber, through the slot in the bowl wall to the bowl. As the bowl fills, the float and its valve rise and, when the gasoline has reached its proper height, the cut-off valve is seated, thus interrupting the flow of gasoline. When the needle valve dial registers zero, the valve is closed and no gasoline enters the intake. Turning the dial in a counter-clockwise direction opens the valve.

The partial vacuum created in the intake, when the piston moves down on its suction stroke, draws the gasoline into the intake just at the constricted portion of the tube. At this point, the air has a high velocity due to decreased cross sectional area of the pipe, and consequently the evaporation of the gasoline and the mixing of the air and vapor are facilitated.

Exhaust

The two exhaust valves being only a few inches apart, both cylinders can discharge into one outlet, the inner exhaust pipe, 51 (Fig. 4). The pipe is surrounded by the outer exhaust pipe, the space between forming a water jacket through which the outlet jacket water flows, thus cooling the hot gases. The jacket water leaves the lower exhaust connections by a ¾-inch pipe and is discharged into the exhaust pipe at a point farther aft.

Water Supply

The cooling water for the engine is forced through the jacket by the plunger pump, which is driven from the cam shaft, 21 (Fig. 2) by the gear 31, (Fig. 2) to which gear is attached the connecting rod. As the piston moves out, water is drawn through the check valve, 38 (Fig. 3), which is lifted from its seat. On the return stroke, the lower valve is closed; and the water in the pump cylinder is forced through

the upper valve, the cylinder head, the water channel, 62 (Fig. 5), the cylinder jacket, and the water space between the inner and outer exhaust pipe.

Governor

The governor is of the centrifugal type and regulates the speed by throttling the mixture. It consists essentially of a dash-pot and a plunger, which is thrown outward by centrifugal force against the spring. The motion of the plunger is transmitted, through a system of bell cranks and the loose governor collar, to the butterfly valve in the intake pipe. When the speed of the engine increases above that for which the governor is set, the plunger moves out, rotating the loose collar. This rotation of the loose collar over the inclined projections on the governor collar, moves the loose collar toward the engine.

This moves the vertical connecting link up and causes the butterfly valve to close. The governor is of advantage in automatically preventing racing, when the clutch is disengaged or when the propeller is thrown out of the water in a seaway.

Reverse Gear and Clutch

The reverse gear consists of the bevel gears, 15 (Fig. 1), the small one being fastened to the crank shaft and the large one to the clutch shaft, which is coupled to the propeller shaft by part 36 (Fig. 3). The intermediate bevel gears 16 (Fig. 1), which have bearings in the spider, 35 (Fig. 3), mesh with gears, 15 (Fig. 1). The clutch drum, 18, covers the gears. This drum is divided into two parts by a web. The web is bushed to fit the clutch shaft in rear of the larger gear, 15. The front part of the drum, 18 (Fig. 1), is keyed to the spider, 35 (Fig. 3). The rear part of the drum surrounds the expanding ring, 19 (Fig. 1), which ring is keyed to the clutch shaft. When the engine is running without clutch engaged, gears 16 (Fig. 1) and spider 35 (Fig. 3), run between gears 15 (Fig. 1), without transmitting power to the propeller shaft. When the operating lever is pushed forward, the thimble, shown on the clutch shaft, Fig. 1, is moved forward, forcing outward the dog which operates the eccentric of the expanding ring. This causes the motion which was transmitted only to the clutch drum, 18 (Fig. 1), to be transmitted to the propeller shaft, and the gears do not move with reference to each other, the propeller shaft running at crank-shaft speed.

When the operating lever is pushed to the rear, a band which is attached to the clutch casing, 14 (Fig. 1), grips the clutch drum, 18 (Fig. 1), and prevents the drum from turning. This, in turn, keeps the spider, 35 (Fig. 3), from rotating, and the larger gear, 15 (Fig. 1), must rotate in the opposite direction from the small gear and at reduced speed. This causes the propeller to turn in the opposite direction and moves the boat astern.

Ignition System

Ignition is by means of the ordinary make-and-break system.

The cam shaft, 21 (Fig. 2), to which is fitted gear 29 (Fig. 2), is driven from the main shaft through the valve-gear pinion, 12 (Fig. 1), and intermediate gear, 30 (Fig. 2), which reduces the speed to one-half that of the main shaft. The sparker cam, 27 (Fig. 2), on the cam shaft engages the spark trip, 28 (Fig. 2), which is pivoted at one end of the hanger, on the timer shaft, 42 (Fig. 3).

The spring causes the sparker rod to bear against the spark trip, thus holding the latter against the sparker cam.

The sparker rod is attached at its upper end to the movable contact lever, which carries the movable platinum-iridium spark tip, 54 (Fig. 4). The stationary spark tip is insulated from the spark plug, and is provided with a thumb nut for the attachment of a wire.

Electrical power is supplied either by a six cell battery, or by a magneto on the engine. The magneto is of the ordinary 3-bar, low tension type, geared to the pump crank disk on the cam shaft. One end of the magneto winding is grounded to the frame; the other end is brought out to a insulated terminal.

The wiring is indicated in the diagram shown in Fig. 10. When the switch is thrown to the left, the circuit for the battery is as shown by the small arrows, while the large arrows show the circuit when the switch is thrown to the right.

The magneto generates sufficient current for sparking twice each revolution, but only through a small part of the revolution. It is therefore necessary that the sparker rods drop during the periods of high electro motive force. This period of high E. M. F. is indicated by two diametrically opposite marks on the armature shaft and two marks on the bearings. The sparkers should snap while either of the

marks on the shaft is at or near the last of the bearing marks which any given point on the shaft passes with the proper direction of rotation. Thus, if the top of the magneto shaft turns toward the engine, the sparker rod should drop when the shaft mark passes the mark on the bearing nearest the engine.

When the piston of the forward cylinder has nearly completed the compression stroke, the forward sparker cam is just under the sparker trip. The cam raises the trip, and the sparker rod and the contact is made at the tips. As soon as the cam revolves far enough to release the trip, the spring causes the rod and trip to drop, breaking the circuit suddenly at the tips. The inductance of the circuit is sufficient to produce a hot spark, which ignites the charge in the combustion chamber.

It will be seen that if the time lever is thrown in, the spark will occur earlier than if the lever is in the vertical position.

Lubrication

The Standard engine is equipped with a positive mechanical lubricating system in which oil is distributed from a reservoir over the fly-wheel by means of small pipes or tubes to the cylinders and principal bearings. The oil pipe leading to each bearing is provided with a valve drip, so that the oil flow can be observed and regulated.

The oiler consists of a small tank containing an arm carrying three small cups, which dips periodically under the oil in the tank, rises, and empties the contents of the cups into five oil tubes. The arm is driven from the cam shaft by means of a worm gear. The amount of the oil fed to the bearings and the cylinders is thus directly proportional to the speed.

Each crank-pin bearing is lubricated by means of a grooved ring fastened to the crank and concentric with the main shaft, from which a channel leads to the bearing. Oil flows by gravity from the oiler through one of the five tubes to drips over the center crank shaft bearing. Here it is distributed to three tubes, the tube on one side leading to the grooved ring on the after crank; that on the other side, to the ring of the forward crank; and the center tube, to the center crank shaft bearing. The four other tubes carry oil to the forward and rear crank shaft bearings, the intermediate

pinion bearing, the thrust bearing, and the two cylinders. The wrist-pin bearings are lubricated by the oil from the cylinders, the pins being hollow.

All other bearing parts contained in the crank case are lubricated by oil thrown from the moving connecting rods and cranks.

The reverse gear drum is kept one-third full of heavy oil, which is poured in through a screw plug in the drum. This oil lubricates the reverse gears and bearings inside the drum.

To Start the Engine

1. Set the compression release lever aft, so as to relieve the compression. This makes it easier to turn the fly-wheel.

2. *Set the ignition timer lever late*, i.e., in a vertical position against the stop. This is of *great importance*, for, if it is attempted to start the engine with the spark advanced, premature ignition may start the engine in the wrong direction and damage to trips, cams, and shaft, will be almost certain to occur. (See Artillery Bulletin No. 76.)

3. Open the gasoline valve, 68 (Fig. 5), on vaporizer about one turn.

4. If engine is cold, prime by placing a small amount of gasoline in the priming cups.

5. Rapidly raise and lower the vaporizer cover. This produces a slight pressure in the vaporizer and forces some gasoline into the intake pipe.

6. Set the throttle lever about one-third from the left, in the fifth or sixth notch.

7. Throw the spark switch to battery, closing the circuit from the battery to the sparkers and ground through the spark coil. Insert plug in receptacle. The magneto cannot furnish enough current until the engine is in operation.

8. Turn the fly-wheel with starting bar.

After Engine is in Motion

9. Pull out the release lever so full compression is obtained. While the engine will run with low compression, it will deliver very little power.

10. Throw the spark switch from battery to magneto, to save the battery.

11. Throw the clutch in slowly.

12. Open throttle to the right to full speed. The governor will now prevent racing.

13. Adjust the gasoline supply until perfect running is obtained.

To Stop Engine

1. Throw in the release lever. This reduces the jerking when the engine has nearly stopped.

2. *Set the ignition lever late.* This is important for the reasons already set forth.

3. Close the needle valve of the vaporizer. If gasoline is left on, the engine may continue to run with the electric circuit broken, ignition being accomplished by hot carbon in the cylinder.

4. Open the ignition switch.

Adjustments

GASOLINE

1. Be sure the valves from the tank are open.

2. Open the needle valve one turn, if starting for the first time.

3. Rapidly raise and lower the vaporizer lid, thus priming the intake.

4. After the engine is in motion and carrying the load, gradually close the needle valve, until the engine starts to back-fire, knock, or run irregularly; then open the valve until regular operation is just obtained again. The gasoline consumption will then be at minimum and the efficiency of the engine greatest. The valve should be habitually in this position when under way.

ENGINE COOLING WATER

1. See that all valves in the circulating system are open.

2. If starting a new engine for the first time, fill the water jacket around exhaust pipe with water. This will prevent the exhaust pipe from becoming overheated, in case the pump does not fill the system immediately.

3. After the engine is in motion, feel the cylinder and the jacketed exhaust pipe. These parts should be only warm to the hand.

4. If the cylinders and the exhaust pipe are too hot, stop the engine and examine the circulating system, especially the pump valves.

SPARKER

1. Be sure the battery is in good condition and that the sparkers, switch, magneto, battery, and spark coil are connected as explained before.

2. Close the switch to battery and touch one end of a small piece of wire to the insulated sparker thumb-nut. Strike the flipper or other bright part of the engine with the other end of the wire. The spark should be at least 3/16-inch long.

3. See that the tips of the sparker are about 1/16-inch apart, when the cam is not lifting the sparker rod. This can be determined by raising the flipper on the end of the movable terminals. To adjust, loosen the thumb-nut and the wrench nut on the stationary terminal. If the tips are too far apart, turn the terminal rod to the left; if too close, turn it to the right. This adjustment is correct when the flipper can be lifted about 1/16-inch.

4. See that, when running, the sparker rod rises through the hole in the flipper about 1/8 to 3/16-inch *after* contact is made between the spark tips, before dropping.

To adjust, turn the engine over until the rod is about to drop, then see that the washer on top of the rod is about 1/8 to 3/16-inch above the flipper.

5. See that the sparkers are clean and free from carbon or dirt.

6. No definite rule as to timing the spark can be given. In general, the timer should be advanced until, with the minimum consumption of gasoline, the engine runs smoothly and at maximum speed. If the spark occurs too early, knocking will result; and, if too late, the speed will be low.

MAGNETO

1. See that, with the timer advanced to the farthest point ever used in running, the sparker rods drop when one of the marks on the armature shaft coincides with the proper mark on the bearing, as explained before. To adjust, advance the timer to maximum and turn the engine over slowly, until either sparker rod drops. Then, with engine exactly in this position, loosen the magneto drive pinion and turn the shaft until one of the shaft marks coincides with the proper bearing mark. If the top of the shaft turns toward engine, the proper mark will be that nearest the engine. Tighten the nut, and check the adjustment by turning the engine over again until the sparker rod drops.

2. See that the magneto sparks properly. This can be tested by removing the wire from the terminal and attaching a temporary wire to it. With the engine running on the battery, a series of hot, fat sparks should occur, when the end of the temporary wire is brought in contact with the teeth of the gear wheels, which will make and break the circuit. If the proper sparking is not obtained, remove the magneto and test it.

(a) Turn the armature by hand. It should rotate freely if the bearings are all right.

(b) Connect the terminal and the body of the machine by wire. If the armature now turns freely, it indicates dirty bearings or a broken wire in the armature, since no current flows. It should offer considerable resistance every half revolution, and a spark should be obtained if the circuit is broken while the armature turns hard.

(c) If the shaft turns freely for a part of a revolution and then offers considerable resistance every half revolution without any wires attached, a short circuit in the armature or wiring is indicated. The shaft should be removed and the armature and bearings cleaned. The armature is waterproof but will not work under water. It should be kept free from excessive dampness.

3. See that there is a slight amount of lost motion on the driving gear. This lost motion should be perceptible, if the gear is rocked forward and back, and it is absolutely necessary to secure proper operation of the magneto. The shaft should be correctly aligned and should rotate freely.

4. See that all bearings are properly oiled. Two drops of good machine oil should be put on each bearing once a day.

5. See that contacts are clean and tight.

6. Whenever the armature is removed, always place strips of iron across the poles of the magnets, otherwise the magnets will soon get weak. Never remove magnets unless they are broken or need recharging. In replacing them on the machine, be sure that all north poles are on one side and all south poles on the other. As manufactured at the factory, all poles of one kind have countersunk screws, while the opposite poles have round head screws. If one of the magnets be assembled the wrong way, the mangetic field will be so weak that the machine will not operate properly. Be careful never to hit the magnets with a hammer or cause undue shock, as this greatly diminishes the magnetism. When

properly cared for, they should not need recharging for several years.

REVERSE GEAR

1. See that the clutch engages the gear drum promptly, when the hand lever is thrown forward. If too loose, adjust by means of adjusting bolt on dog.
2. See that the gear drum is one-third full of heavy oil.
3. Adjust the external band brake so that it clutches the gear drum firmly, when the hand lever is thrown aft, and that it is loose, when the lever is vertical.
4. See that the dog and rock shaft are well oiled at all times.

INLET VALVES

1. Once in 50 or 60 hours running, remove the inlet dash-pot cover and put some oil on the plunger and on the rods.
2. See that the plungers work freely in the dash-pots.

EXHAUST VALVES

1. These valves should show a bright ring of wearing surface. If pitted or beveled surface is rough, regrind by turning valve on its seat with a small amount of powdered emery. This should be only necessary once each year. Care must be taken to prevent emery from getting into the cylinders.

OILING

1. Be sure that all bearings and the cylinders are receiving oil properly. The rate of flow should be observed and regulated.
2. All oil pipes should be flushed with kerosene once each month, so as to be sure that oil flows freely.
3. Do not allow old oil to accumulate in the base or under the reverse gear.
4. It is much better to feed too much oil to a bearing than not enough.

To Put Engine Out of Commission

1. Drain all piping.
2. Run the engine for about a minute without water, until the cylinders and exhaust pipe become very warm to the touch; then stop the engine.

3. Cover all bright surfaces with slushing oil.

4. Flood a quantity of oil into the cylinders.

5. Take off the cylinder heads; oil valve seats; and pour some oil down the valve stems.

6. In general, see that all parts are protected against corrosion, especially, rusting due to moisture.

NAMES OF PARTS OF STANDARD ENGINE

(Figs. 1–7.)

No. of Part on Fig. 7	Fig. No.	No. of Part	Part
	1, 3	1	Fly wheel.
	1	2	Crank.
E²e 10	1	3	Crank pin.
Ee 13	1, 3	4	Connecting rod.
Ei 14	1	5	Crank pin brasses.
Ee 6	1, 3	6	Piston.
Ee 8	1	7	Piston rings.
Ee 7	1	8	Wrist pin.
	1	9	Oil ring, to carry oil to crank pin bearing.
	1	10	Main journal.
	1	11	Main bearings, upper half.
	1	12	Timing gear pinion.
	1, 3	13	Crank case, lower half.
	1	14	Clutch casing, clutch is to connect crank shaft with propeller shaft and to reverse direction of rotation of propeller.
	1	15	Bevel gears, 30 and 39 teeth.
	1	16	Intermediate bevel gears.
	1	17	Front supporting ring for clutch drum.
	1	18	Clutch drum.
	1, 3	19	Expanding ring.
E¹e 4	2, 3	20	Crank case, upper half.
E¹e 23	2	21	Cam shaft.
E¹e 24	2	22	Exhaust cam.
Ee 25	2	23	Exhaust valve lifter.
Ee 26	2	24	Cam roller.
	2	25	Auxiliary exhaust cam. To release compression when starting.
Ee 37	2	26	Valve lifter shifting rod. To shift valve lifter so that cam roller runs over auxiliary cam.
Ei 1	2	27	Igniter cam.
Ei 3	2	28	Tripper.
	2	29	Cam shaft pinion. (Timing gear.)
	2	30	Intermediate gear. (Idler.)
	2	31	Pump crank disk and spiral gear for driving magneto.
	2	32	Worm, for driving lubricator.

No. of Part on Fig. 7.	Fig. No.	No. of Part	Part
	2, 3	33	Opening to channel in wall of crank case; to attach pipe for carrying warm air from exhaust manifold to vaporizer (carburetor).
	2	34	Pivot for compression release lever.
	3	35	Intermediate bevel gear spider.
	3	36	Coupling, for attaching propeller shaft to clutch shaft.
	3	37	Pump, for circulating cooling water.
	3	38	Pump valve bonnets.
	3	39	Suction.
	3	40	Discharge.
	3	41	Magneto.
E1i 8	3	42	Ignition timing shaft.
E1e 1	3, 4	43	Cylinders.
E1e 3	3, 4, 5	44	Cylinder head.
	3	45	Priming cup.
	3	46	Water inlet to cylinder jacket.
	4	47	Exhaust port.
	4	48	Water connection to exhaust manifold.
Ee 29	4	49	Exhaust valve.
Ee 33	4	50	Valve spring.
Ee 48	4	51	Exhaust manifold.
	4	52	Sleeve from which warm air is carried to carburetor.
Ee 43	4, 5	53	Intake valve.
	4	54	Ignitor.
	4	55	Water connection with pump.
	4	56	Water connection, head to cylinders.
	4	57	Vaporizer connection.
	4	58	Whistle valve.
Ee 44	5	59	Inlet valve plunger.
Ee 45	5	60	Inlet valve dash pot.
Ee 47	5	61	Inlet valve spring.
	5	62	Flanged brass water pipe, head to cylinder jacket.
	5	63	Water pipe, pump to cylinder head.
	5	64	Inlet pipe, vaporizer to inlet valves.
	5	65	Vaporizer or carburetor.
	5	66	Throttle lever.
	5	67	Lubricator.
	5	68	Needle valve, regulates gasoline supply.

THE LATHROP ENGINE

This engine is built by the J. W. Lathrop Co., Mystic, Conn., and is the kind which is installed in Mine Yawls. It is single cylinder, two-cycle, two-port, 6.5-inch bore by 6.5-inch stroke, and develops 8 horsepower at a speed of 350 revolutions per minute.

Cylinder

The cylinder and crank case are cast in one piece. The crank shaft bearings are held in plates which are bolted to the ends of the crank case. There is a plate bolted on each side of the crank case. To the plate, 32 (Fig. 13), on the port side is attached the inlet pipe from the carburetor, 10 (Figs. 11 and 13). To the plate, 34 (Fig. 13), on the starboard side is attached a hand oil pump, 35 (Fig. 13), for lubricating the crank pin, 24 (Fig. 12). There is also a small opening in the bottom of the crank case which is closed by a plate. All these plates are fitted with gaskets so that the joints are air tight. The cylinder head, 2 (Figs. 11 and 12), is held in place by seven nuts. There is a tapped hole in the head of the firing plug, 3 (Figs. 11, 12, and 13), which carries the insulated part of the make-and-break ignition system. The cylinder is water jacketed. Water is forced by a plunger pump, operated by the eccentric rod, 13 (Figs. 12 and 13), through the check valve, 39 (Fig. 11), into the cylinder jacket, and then by the pipe, 36 (Fig. 11), to the jacket of the exhaust outlet. From the exhaust outlet, if the valve, 41^1 (Fig. 11), be open, part of the water flows through the jacketed check valve, 19 (Fig. 11), then overboard; and part flows through 41^1 (Fig. 11) into the exhaust silencer. The cylinder head contains a water space which connects with the cylinder jacket by small holes. A gasket of wire mesh and asbestos is placed between the head and the cylinder. On the lower part of the base are cast heavy flanges for bolting the engine to the timbers by which it is secured to the boat.

Piston

The piston, 15 (Fig. 12), is fitted with three piston rings, 17 (Fig. 12), for preventing leakage of gas. The deflector

plate, 16 (Fig. 12), is a part of the piston casting. The wrist pin, to which is clamped the connecting rod, 18 (Fig. 12), works in holes in the piston. Oil holes are drilled diagonally downward to the wrist pin.

Lubrication

Some of the oil fed to the cylinder by the double lubricator, 6 (Figs. 11 and 13), oils the wrist-pin bearings. The crank pin, 24 (Fig. 12), to which the connecting rod is attached by the crank-pin brasses, 19 (Fig. 12), is lubricated partly by the double lubricator and disk, and partly by means of the hand oil pump, which throws a stream of oil which is caught by the perforated plate, 20 (Fig. 12), and from this runs to the crank pin. The rate of flow, for double lubricator, should, as a rule, be about thirty drops per minute to the cylinder and crank pin. Experience may show that less oil can be used. The hand pump should be operated three strokes every fifteen minutes. The main or crank-shaft bearings, the brake band of the reverse gear, and the rear bearing of the reverse gear are lubricated by grease cups. A good quality of grease with which flake graphite has been mixed should be used. Screw the cups down one-half turn every fifteen minutes. The reverse gear case should be kept filled with a mixture of grease, cylinder oil, and graphite. Use enough oil to soften the grease so that it will flow over the gears. If a "grease gun" is not available, one of the grease cups and its tube may be removed from one of the main bearings and used to force grease into the reverse gear case. One filling should last for three or four months. Too much oil and grease can do no damage.

Ports

Burned gas is discharged from the cylinder through the exhaust ports, 37 (Fig. 14), which lead to the exhaust outlet, 11 (Figs. 11 and 13). A fresh charge of gas is taken into the cylinder through the inlet ports, 38 (Fig. 14). The inlet ports connect with the crank case by means of a channel in the cylinder wall. The piston uncovers the exhaust port enough to release the pressure of the burned gas from the cylinder before the inlet port opens. When the inlet port is uncovered by the piston, the mixture of air and gasoline, which is compressed in the crank case, flows into the cylinder, striking the

deflector plate on top of the piston. This plate prevents the fresh charge from going out through the exhaust port.

Carburetor

The Schebler carburetor, Model D, 10 (Figs. 11 and 13), is furnished with the Lathrop engine. Gasoline flows to the carburetor by gravity. The bowl contains a cork float to which is attached the float valve. The float lever is so adjusted that the level of gasoline in the bowl is kept slightly below the opening in the spray nozzle. The float valve closes the opening through which gasoline flows into the carburetor when the gasoline has risen to the proper level. The spray nozzle carries gasoline from the float chamber into the L shaped opening in the center of the bowl. The suction caused by the upward movement of the piston draws air through the air valve, downward past the spray nozzle, past the throttle and through the check valve into the crank case. The rate of flow of gasoline, upon which depends the richness of the mixture, is regulated by the needle valve. This valve is located under the bowl. It is closed by turning it clockwise. As this engine does not have a wide range of speed, adjust the carburetor for normal operation by putting only a moderate tension on the spring of the air valve. Then when the engine is working, gradually close the needle valve until the engine's speed drops slightly. This indicates that the mixture is too lean. Then open the needle valve slowly till the engine gets up to speed.

Check Valve

A check valve, 9 (Fig. 11), is located between the carburetor and the crank case. This is necessary in a two-port, two-cycle engine to hold the charge under compression in the crank case. The opening of the check valve can be varied by the adjusting screw on top. This opening should be about 3/16 of an inch. In warm weather the opening may be a little more. If the opening is too great, the gasoline will not be perfectly vaporized. The check valve is water jacketed so that warm water flows around it. This aids the vaporization of the gasoline and prevents the formation of frost in the valve, which may occur in cool, damp weather.

Governor

The engine is kept from racing, when the reverse gear

lever is placed on neutral, by a governor which controls the speed by throttling the mixture. The governor consists of a small weight carried on the fly-wheel. The weight is attached to one end of a bell-crank lever. The other end of the lever bears between two lugs on a collar, which is free to turn for a short distance on the crank shaft. An inclined slot is cut in the collar. A pin projects from the shaft through this slot. A spiral spring is attached to the governor weight. When the speed of the fly-wheel is sufficient to throw the weight toward the rim of the wheel, the collar is turned for a short distance around the shaft. On account of the inclined slot, the collar will travel along the shaft. A groove is cut in the collar, and in this groove runs a lever which is connected by suitable links with the throttle. By adjusting the spring, the speed at which the engine will partly close the throttle can be regulated. If the spring is tightened, the engine will run at a higher speed.

Pump

A plunger pump is used to force the cooling water through the jackets. The plunger, 14 (Figs. 12 and 13), is operated by the eccentric, 13 (Figs. 12 and 13), which eccentric also operates the make-and-break ignition. The plunger works in a stuffing box which should contain hemp packing and not be too tight. The pump is fitted with two check valves, one on the suction and one on the discharge side. The suction leads to a strainer on the bottom of the boat and the discharge is through the valve, 39 (Fig. 11), to the cylinder jacket.

Ignition System

The make-and-break ignition system is used on this engine. Current is furnished by two sets of eight dry cells connected with a spark coil by a two-way switch. Either battery may be used. The spark coil consists of a number of turns of insulated copper wire wound on a bundle of soft iron wires. One terminal of each battery is connected with each side of the switch. The other battery terminals are connected with the frame of the engine. The pivot of the switch is connected with one terminal of the spark coil. The other terminal of the spark coil is connected with the firing plug, 3 (Figs. 11, 12, and 13). The central pin of the firing plug, which carries the binding screws, is insulated with mica bushing from the body, which is screwed into the cylinder

head. When the firing shaft, 29 (Fig. 13), turns so as to make contact with the insulated pin of the firing plug, the circuit is completed through the engine. The firing shaft arm is normally held up by the spring, 40 (Fig. 11), so that the shaft is turned to such a position that the lug on the end of the shaft, 29 (Fig. 13), makes contact with the insulated pin of the plug, 3 (Figs. 11, 12, and 13). As the firing slide, 7 (Figs. 11, 12, and 13), is raised by the eccentric rod, 13 (Figs. 12 and 13), which runs on an eccentric on the crank shaft, the spring, 41 (Fig. 11), is compressed by the action of the latch, 42 (Fig. 11). This latch is released by striking a pin, the position of which is varied by the timing lever, 5 (Figs. 11 and 12). When the latch releases the spring, the spring strikes the firing shaft arm and suddenly separates the lug on the end of the firing shaft from the insulated pin of the firing plug. The breaking of the electric circuit produces a spark which ignites the charge in the cylinder. By moving the timing lever, 5 (Figs. 11 and 12), the time at which a spark occurs during a stroke of the piston can be varied. For starting, the spark should occur late. This means that the spark occurs after the crank has passed the inner dead center and the piston has started on its downward stroke. When the engine is running under load, advance the spark as far as possible without causing the engine to knock. The engine runs in a counter-clockwise direction, as viewed facing the fly-wheel. To determine whether or not the electrical connections are in order, turn the firing shaft so that it does not make contact with the insulated pin. With the battery switch closed, make a connection by means of a short piece of wire or a screw-driver from the spark plug to the cylinder. If everything is right, a bright spark should be made.

Reverse Gear

The purpose of a reverse gear is to run the boat astern without changing the direction of rotation of the engine, and to bring the boat to a stop without stopping the engine. The Paragon reverse gear is used with the Lathrop engine. When the boat is running ahead, the lever is pushed ahead. This pushes a sleeve forward on the shaft that is connected with the propeller and causes three toggles to spread three fingers. The fingers force the finger disk, which is fastened by four pins to the gear case, 30 (Fig. 12), against five friction disks, three steel and two bronze, which cause the whole reverse

gear (and disk clutch) to rotate at crank shaft speed. Since the propeller is connected with the gear, 27 (Fig. 12), the propeller rotates at crank shaft speed and none of the gears rotate on each other. The gear, 27 (Fig. 12), is free to rotate inside the case, 30 (Fig. 12), except when held by the friction disks.

To reverse the propeller, the lever is pulled astern. This clamps a brake band on the gear case, 30 (Fig. 12), and, as the band is fitted with lugs which rest on the frame, the case is prevented from turning. The engine gear, 25 (Figs. 12 and 13), is fastened to the crank shaft. The pinion gears, 26 (Figs. 12 and 13), are attached to the reverse gear cover, 31 (Fig. 13). As the cover is bolted to the gear case, 30 (Fig. 12), the pinion gears can rotate on their shafts only. Since the crank shaft and engine gear rotate in a counter-clockwise direction, facing the stern of the boat, the top of the pinion gear, 26 (Figs. 12 and 13), moves to the right, i.e., rotates clockwise, and the four pinion gears move in the same direction and at the same rate. The propeller gear, 27 (Fig. 12), meshes with the four pinion gears. Since the top of the pinion, 26 (Figs. 12 and 13), moves to the right, the propeller gear will move around the pinion gears to the right, and thus will rotate in the opposite direction from that in which the crank shaft rotates. This reverses the direction of rotation of the propeller and causes the boat to run astern.

Propeller Shaft

This shaft carries the propeller. It is attached by a flanged coupling to the reverse gear. It runs in two combined bearings and stuffing boxes, one at the outer and one at the inner end of the shaft log. These stuffing boxes are joined by a brass pipe which screws into each stuffing box.

In operating a boat, great care should be taken to avoid striking the propeller or rudder against any obstruction.

To Start the Engine

See that the reverse gear lever is in the neutral position. Open the valve between the gasoline tank and the carburetor. Set the timing lever so that the spark will occur late. With the battery switch open and the priming cock and throttle open, turn the fly-wheel over two or three times. Then, if the weather is cool, prime the cylinder with gasoline. Close the priming cock and the ignition switch. Then, by using the

starting handle in the fly-wheel, rock the wheel with the handle near its lowest point and lift up quickly, so as to turn the wheel in a clockwise direction. This is the opposite direction from that in which the engine should run and raises the piston against compression. Let go the handle before it gets to the highest point. The timing lever being set late, a spark occurs before the piston reaches its highest point. This fires the charge in the cylinder and forces the piston down, turning the fly-wheel in a counter-clockwise direction. Start the oil feed and screw up the grease cups. Advance the spark slightly. As the engine takes the load, advance the spark as far as possible without causing knocking. To stop the engine, open the battery switch and close the oil feed and the valve in gasoline line.

(Note:—Ordnance Pamphlet No. 1887, price list of the articles of submarine mine equipment, gives a price list of parts and drawings of the Lathrop engine, Schebler carburetor, and Paragon reverse gear.)

NAMES OF PARTS OF TH LATHROP ENGINE

(Figures 11–14.)

Fig. No.	No. of Part		Fig. No.	No. of Part	
11, 12	1	Cylinder.	12	20	Plate for catching oil from hand oil pump for lubricating crank pin.
11, 12	2	Cylinder head.			
11, 12, 13	3	Firing plug.			
11	4	Priming cup.			
11, 12	5	Timing lever.	12	21	Flanged coupling.
11, 13	6	Double lubricator for cylinder and crank pin oiling disk.	12	22	Propeller shaft.
			12	23	Propeller.
			12, 13	24	Crank pin.
11, 12, 13	7	Sparking slide.	12, 13	25	Engine gear.
11, 12	8	Fly-wheel.	12, 13	26	Pinion gear.
11, 13	9	Check valve.	12	27	Propeller gear.
11, 13	10	Carburetor.	12	28	Rear bearing, upper half.
11, 13	11	Exhaust outlet.			
11	12	Exhaust silencer.	13	29	Firing shaft.
12, 13	13	Eccentric strap.	12	30	Reverse gear case.
12, 13	14	Pump plunger.	13	31	Reverse gear cover.
12	15	Piston.	13	32	Crank case cover plate, carburetor connection.
12	16	Deflector plate.			
12	17	Piston ring.			
12	18	Connecting rod.	11, 13	33	Link, governor to throttle.
12	19	Crank pin brasses.			

Fig. No.	No. of Part		Fig. No.	No. of Part	
13	34	Crank case cover plate, hand oil pump connection.	11	39	Discharge check valve of water pump.
13	35	Hand oil pump.	11	40	Spring for spring post.
11	36	Water connection, top of cylinder to exhaust outlet.	11	41	Large spring.
			11	41′	Cooling water valve.
14	37	Exhaust port.	11	42	Latch.
14	38	Inlet port.			

SUGGESTIONS FOR THE MAN IN CHARGE OF THE BOAT ENGINE

Be sure that there is no leak in the gasoline tank or the pipe leading from the tank to the carburetor. If a leak is suspected, on account of the smell of gasoline, close the valve at the carburetor and feel all joints in the pipe line and the bottom of the tank. There might be a small leak from which gasoline would not drip on account of rapid evaporation, especially in warm weather. If the fingers are moistened with a small amount of gasoline, there will be a feeling of cold, caused by evaporation. *Do not bring a light other than electric, such as a pocket flash lamp, near the gasoline tank and pipe line.*

Water in the gasoline will cause the engine to run irregularly, as it will get into the spray nozzle of the carburetor and cause uneven mixture of air and gasoline. There should be a strainer in the pipe line. Open this occasionally before starting the engine, being careful to catch the small amount of gasoline drained off in a can or bottle, so that no gasoline will get in the bottom of the boat. If water is present, it will settle to the bottom of the can and can be readily distinguished from gasoline by difference in color. If the presence of water is suspected, close the valve leading to the carburetor and remove the drain plug below the needle valve. Catch the gasoline, so that you can be sure whether or not water was present to cause any trouble. It is a good plan when filling the tank, to strain the gasoline through a chamois skin, placed in a large funnel. This prevents the entrance of water to the tank, as well as catching dirt.

Many boats have the gasoline tank located so that it is very difficult to remove the tank for cleaning or repair. Every time the engine is overhauled, drain the gasoline tank and remove all sediment which it is possible to remove. In some cases, it will be necessary to wipe the bottom of the tank with a piece of muslin which has been dipped in kerosene.

Do not feed too much oil to the cylinders, as this will cause excessive carbon deposits and fouling of the igniters. Too much oil in the cylinders is indicated by blue smoke from the exhaust. Some of the carbon formed in the cylinders

will work into the piston ring grooves, causing the rings to stick, thereby losing compression and power. If the igniters become fouled with oil and carbon, the engine will miss explosions. Hot particles of carbon also cause pre-ignition and pounding. A great deal of trouble from the effects of carbon can be avoided by injecting, weekly, about a gill of kerosene, with which is mixed some flake graphite, into each cylinder, through the priming cocks, when the engine is warm; turn the engine over by hand a few times, and do not start for several hours. Be sure that the valves (or the ports in case of a two-cycle engine) of the cylinder into which you are putting the kerosene are closed so that the kerosene will run down on top of the pistons and not out the ports. Graphite is an excellent lubricant and will also form a thin film over the piston and cylinder head and will prevent carbon from sticking tightly.

Do not take apart any portion of the engine, unless you are sure that by doing so you can remedy some defect or improve the operation. Avoid the use of a hammer, a cold chisel, and a monkey-wrench. There should be provided, for efficient operation of an engine, a set of wrenches, such that a wrench can be had which will fit every nut which it is ever necessary to remove.

Every time the crank case cover is removed for the purpose of taking surplus oil from the bottom of the crank case, examine the crank pin bearing bolts.

See that all nuts are kept tight. Don't forget the propeller shaft stuffing box that is attached to the inner end of the shaft log. See that the grease cup is screwed up frequently, that packing is good, and that the follower is not too tight. It takes very little pressure on the shaft to keep water out of the boat. See that the packing between the flange of the stuffing box and the shaft log is in good order.

Remember that the man in charge of the engine is responsible for any damage to a Standard engine, resulting from failure to retard the spark when starting or stopping.

Be sure to drain the water circulating system in cold weather.

CARE OF A BOAT

A boat should be removed from the water at least twice a year and have its bottom scraped and painted with brown "copper paint." If teredoes have attacked the planking or keel, dig them out with a small screw-driver or steel wire. Cut off any part of the keel which has been badly eaten and plug the holes with a mixture of white lead and tallow.

If any seam has been leaking, scrape out the old caulking material and pack the seam with oakum. See that the propeller stern bearing and the rudder are in good condition.

If any iron work shows rust, scrape and paint with red lead before applying other paint. In Fig. 16 is shown a convenient type of railway for pulling small boats out of the water.

Keep a serviceable bilge pump on hand, and keep the bilge free from water.

If a boat is engaged in such work that the paint is scraped off the outside or inside, touch up the bare spots as soon as possible. Lack of paint will, in time, allow the timber to rot, as well as appearing unsightly.

All brass which is not painted must be kept polished. See that the lights are in good order. Every power boat is required by law to carry two copies of pilot rules, issued by the Department of Commerce. All men who are on duty on any boat used in mine planting work must be familiar with these rules.

(Note:—The publication referred to is Pilot Rules, Form 804, Department of Commerce, Steam-Boat Inspection Service. These can usually be obtained from the local steamboat inspector.)

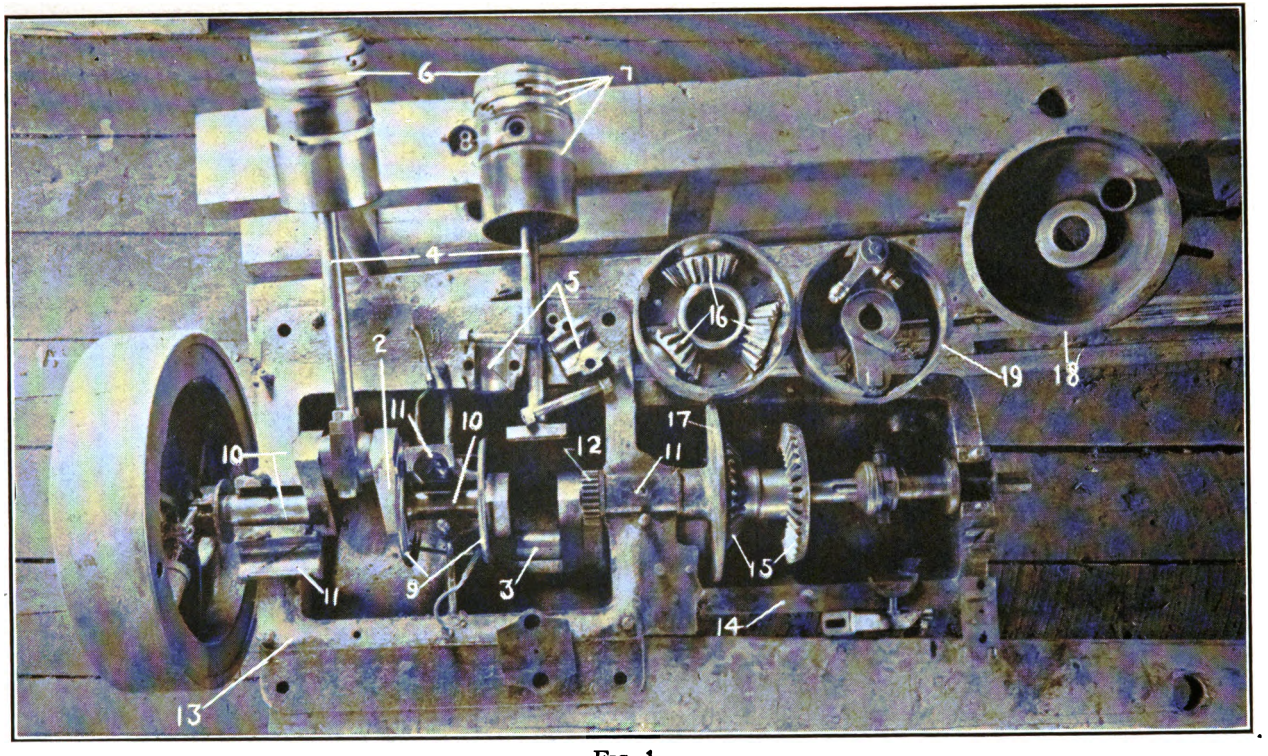

FIG. 1.

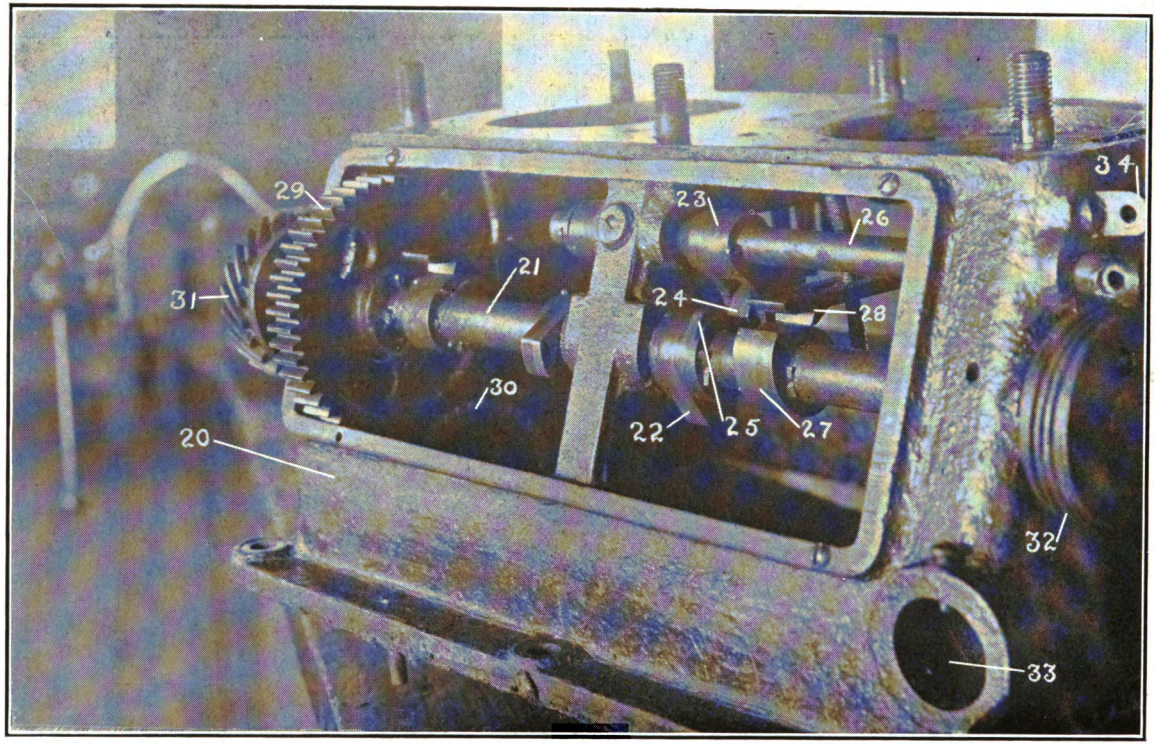

FIG. 2.

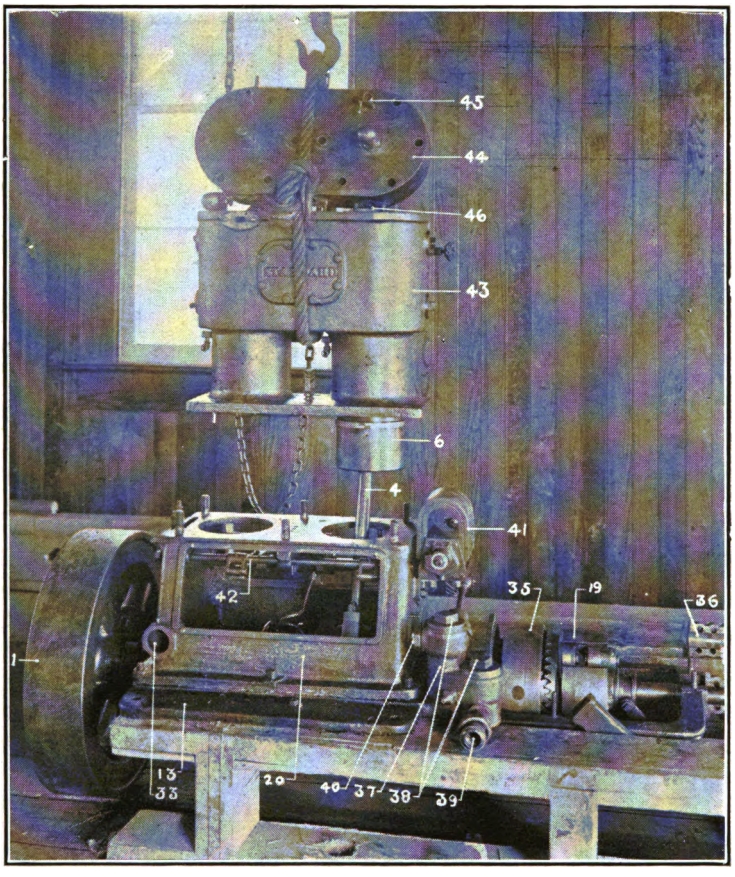

FIG. 3.

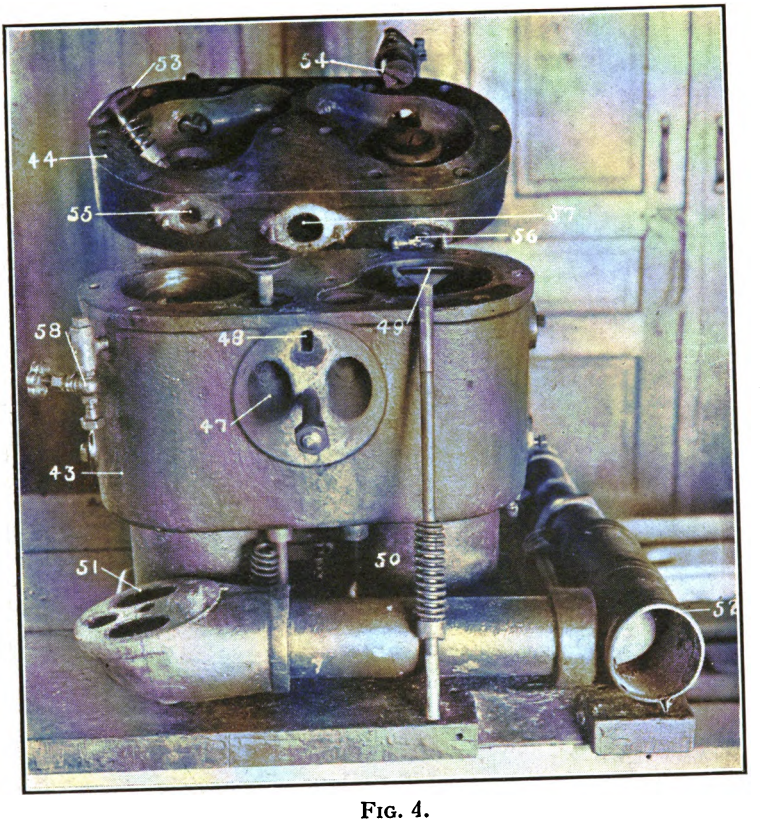

FIG. 4.

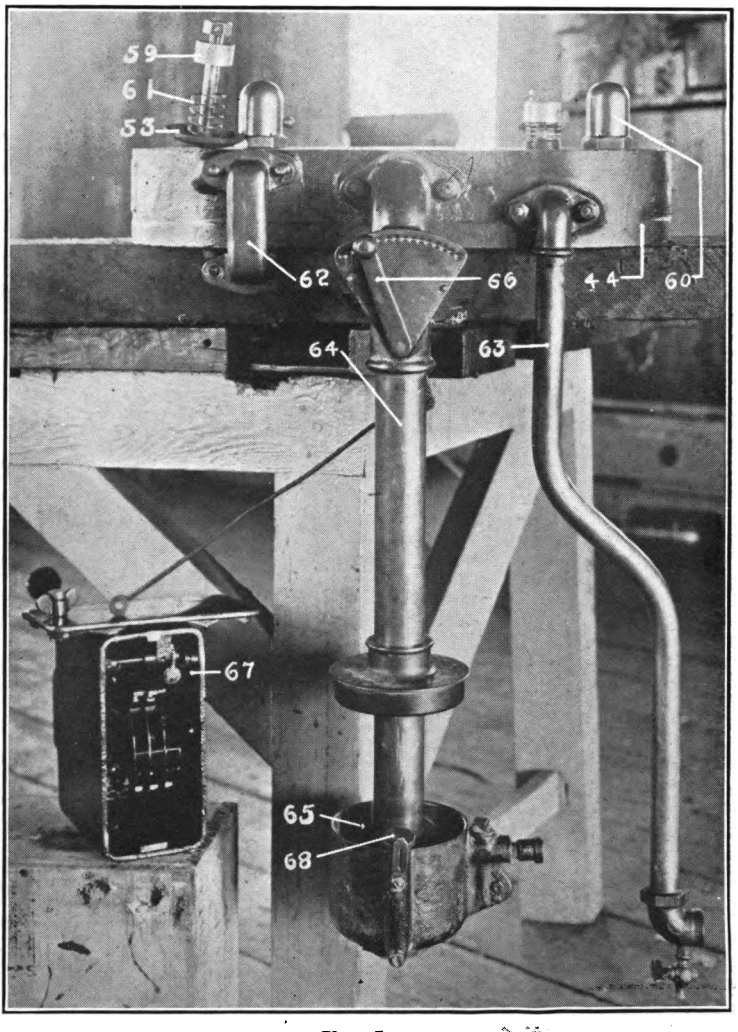

FIG. 5.

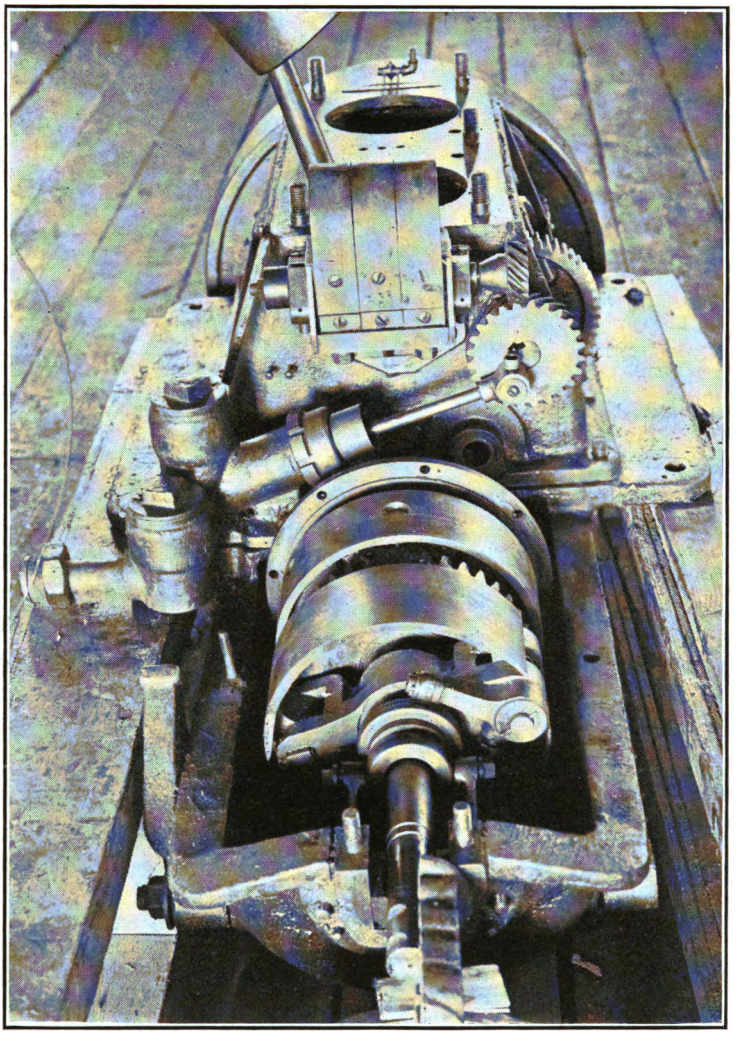

FIG. 6.

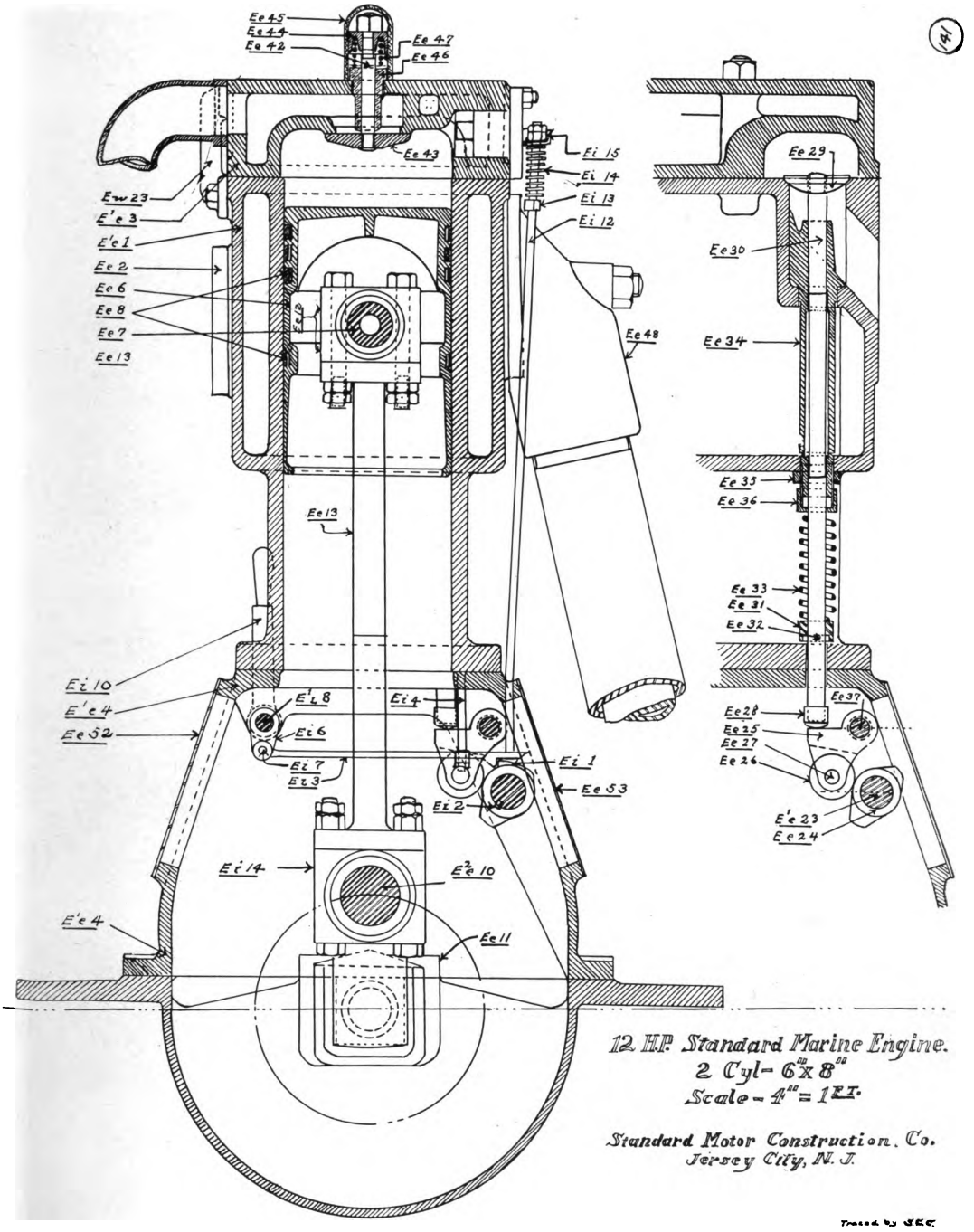

FIG. 7.

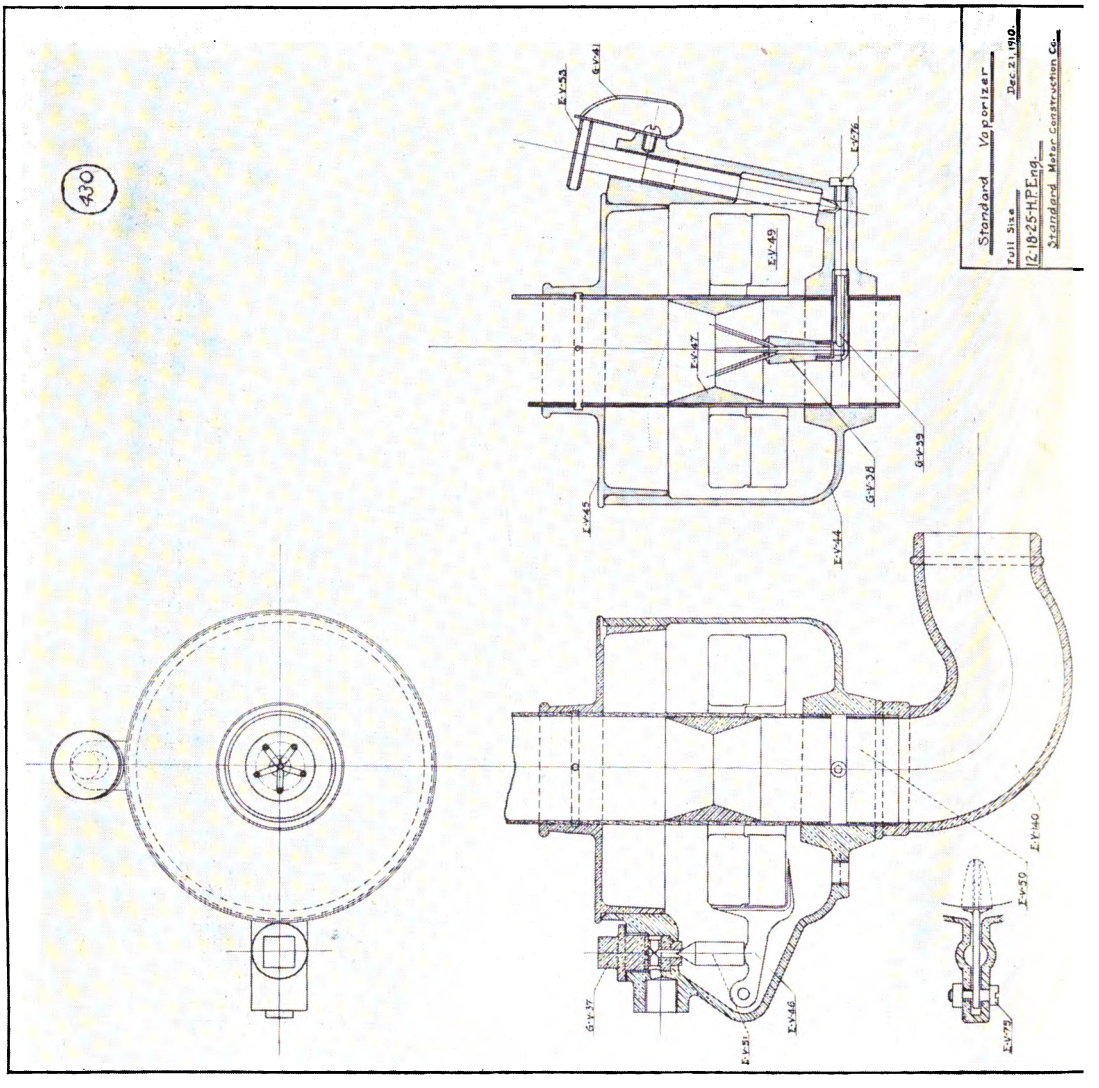

FIG. 8.

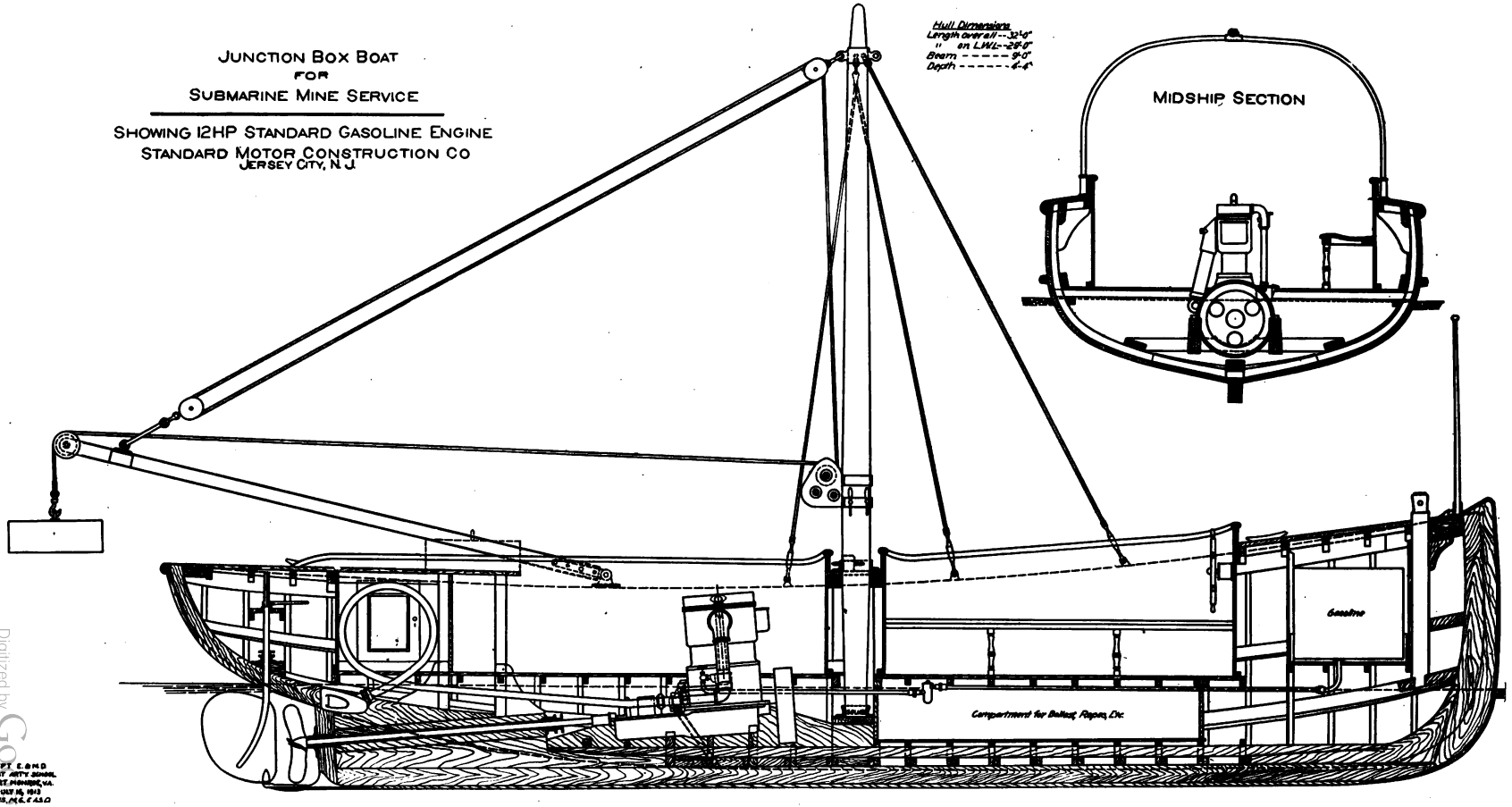

FIG. 9.

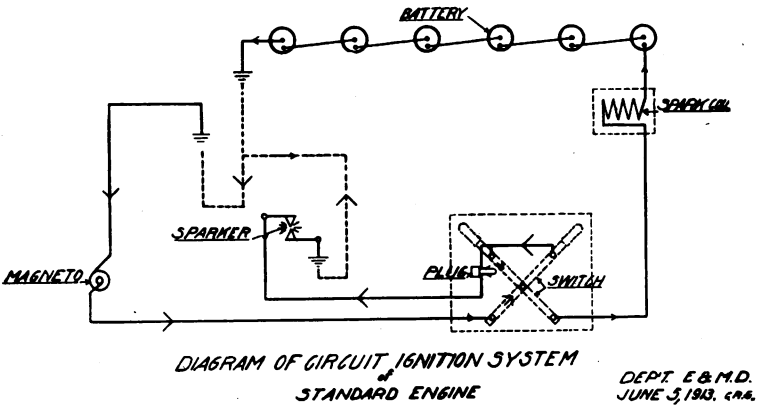

FIG. 10.

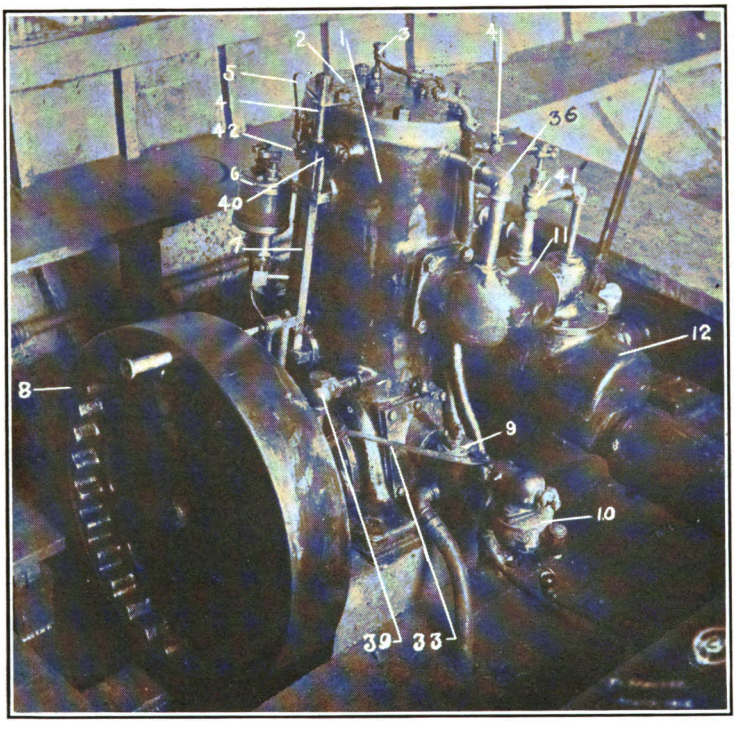

FIG. 11.

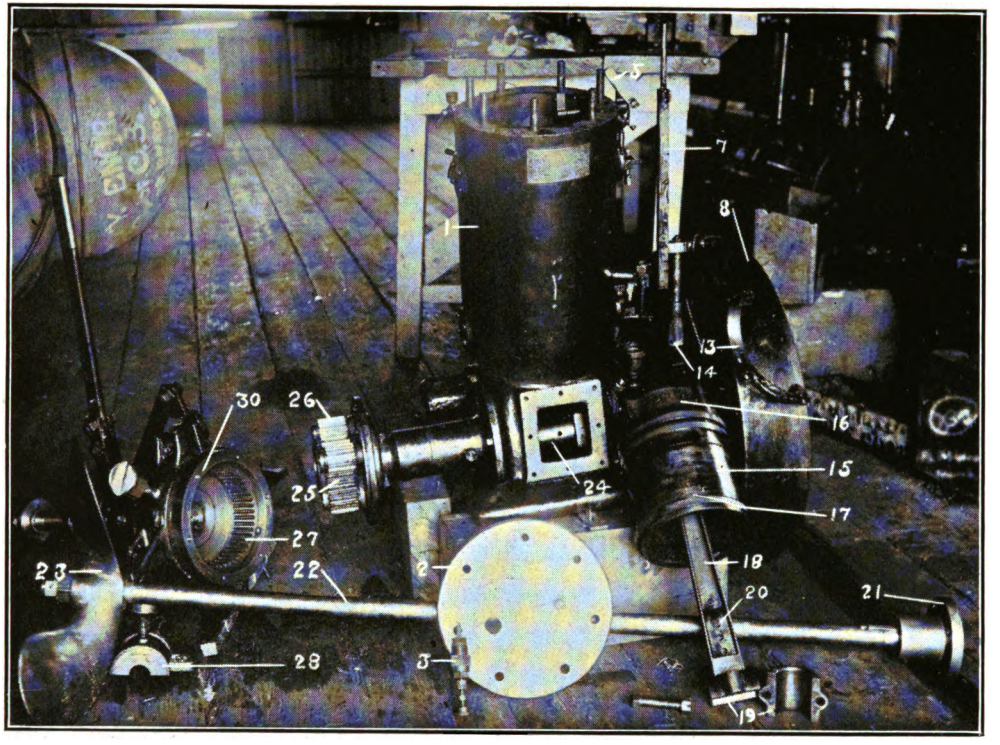

FIG. 12.

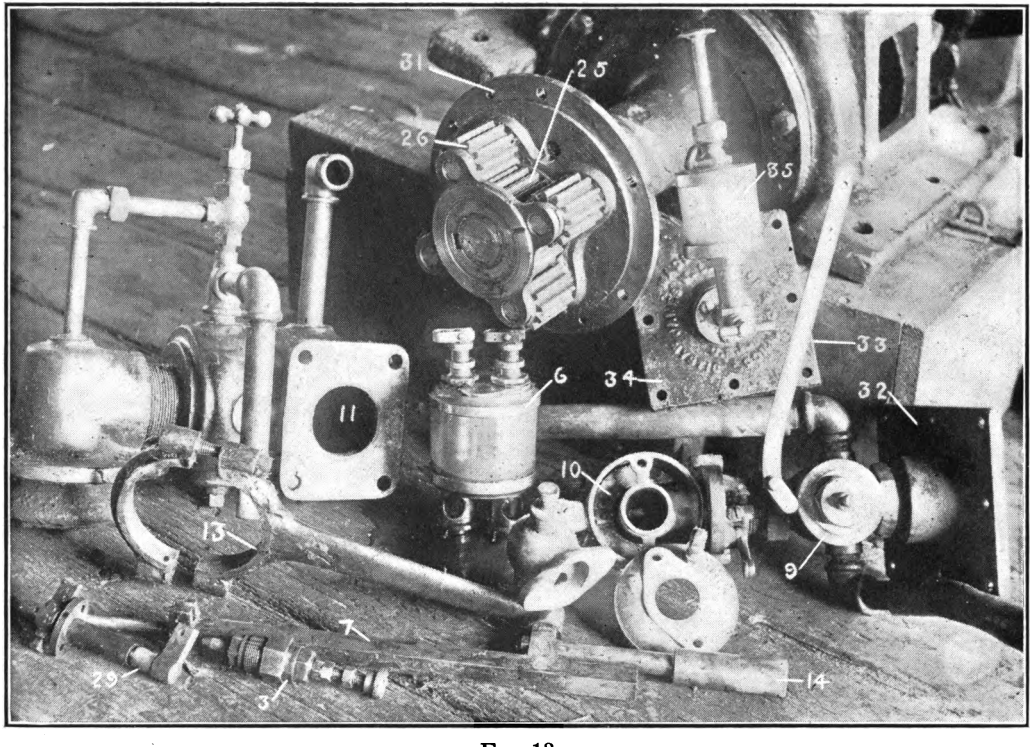

FIG. 13.

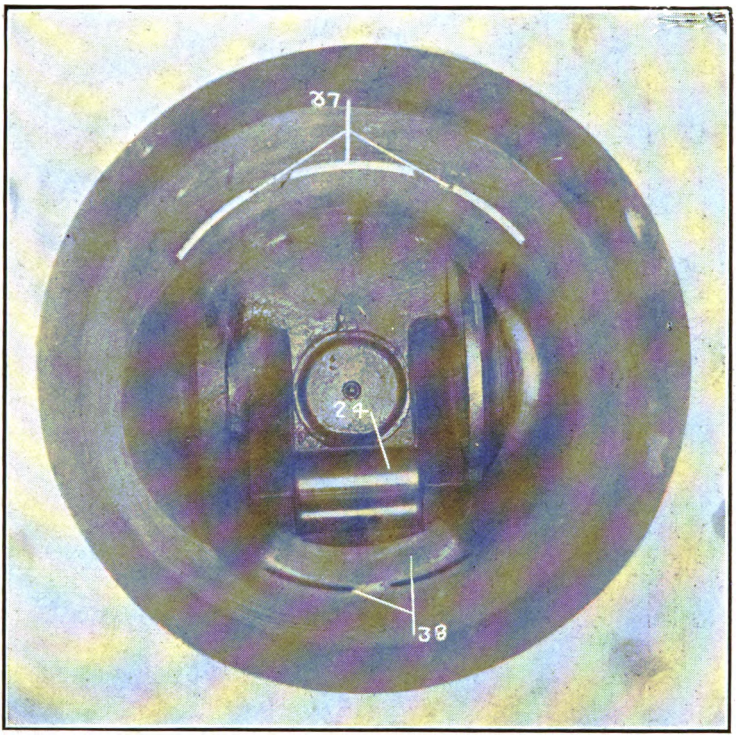

FIG. 14.

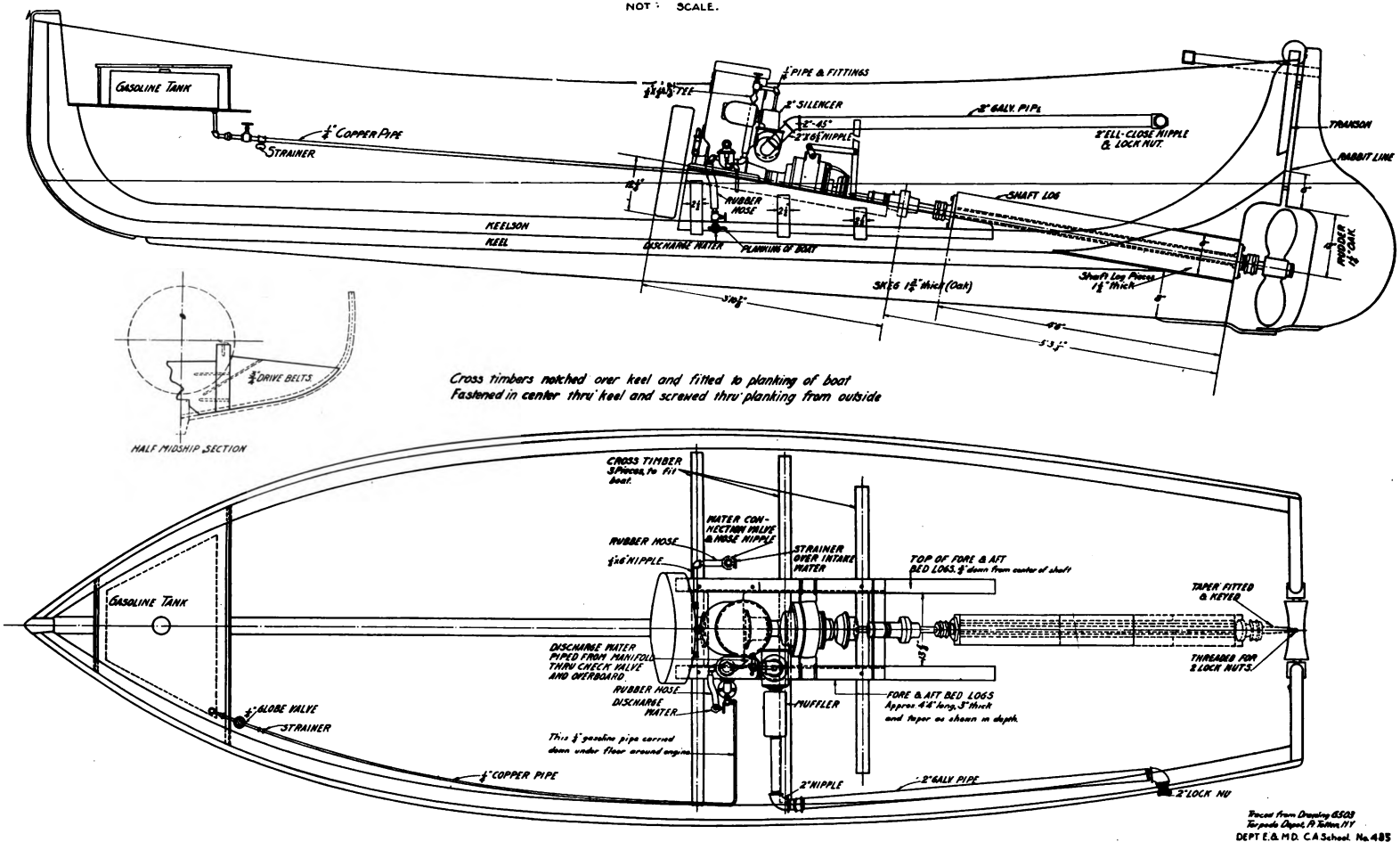

FIG. 15.

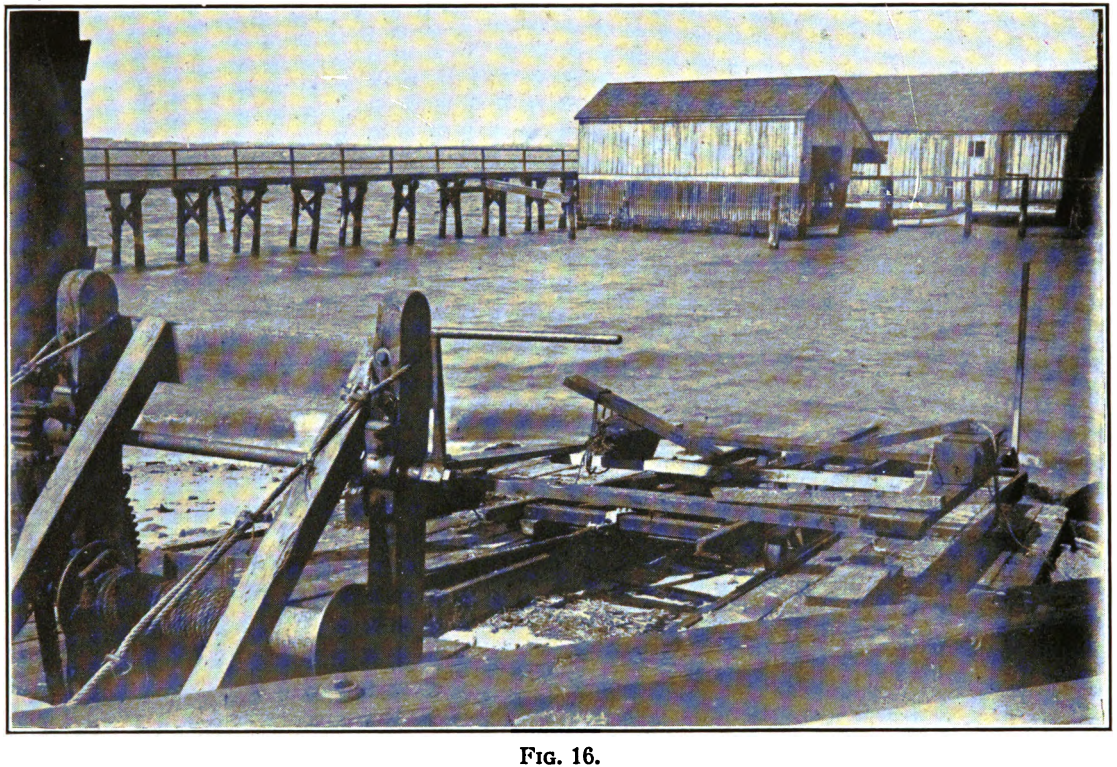

FIG. 16.

Present Status of the Series of Artillery Notes

No.		Title
*†	1	Instructions for Regulating Powder Charges of Coast Artillery in Target Practice.
*†	2	Armor Attack Sheet.
†	3	Directions for Setting Up, Adjusting, and Using the Lewis Type "A" Depression Position Finder.
*†	4	Proceedings of a Board of Officers, Convened at Governors Island, New York, for the Purpose of Preparing and Formulating a System of Electrical Communication for Artillery Fire Control.
*†	5	Construction of a Difference Chart.
*†	6	Description and Diagram of the Telautograph.
*†	7	Curves and Tables of Robinson's Anemometer.
*†	8	The Lewis Depression Position Finder. Function and Method of Operation of the Elevating Screw. Device for Illuminating the Cross-Wires. Supplement to Artillery Note No. 3.
*	9	Searchlights.
*	10	Mortar Zones and Mortar Range Tables.
	11	Seacoast Engineering.
*	12	Notes on Oil Engines.
*†*a*	13	System of Nomenclature of Parts of Modern Batteries.
*	14	Form for "Report of an Inspection Relative to Coast Artillery Instruction, the Condition of the Batteries, and the Fire Control and Direction System."
*†	15	Test of Experimental Fire Control Installation at Pensacola, Florida.
*†*b*	16	Notes on Explosives.
	17	Notes on the Telephone.
*†	18	Theory of the Storage Battery.
	19	Digest of Orders and Circulars Issued by the War Department Pertaining to the Care and Use of Seacoast Armament from January 1, 1896, to January 1, 1904.
*†	20	Correspondence Relative to Preparation of Data for Elevation Scales of Seacoast Guns.
*	21	Topical Index of Artillery Subjects.
*†	22	Practical Method of Adjusting a Modern Gun.
*†	23	Discussion Bearing on the Tactical Use of Mortars.
	24	Topical Index of Artillery Subjects. Supplement to Artillery Note No. 21.
	25	Note on Ballistic Tables.
	26	Construction of a Difference Chart.
	27	Topical Index of Artillery Subjects. Second Supplement to Artillery Note No. 21.
	28	A Study of Attacks Upon Fortified Harbors.
	29	Correction of Range Scales for Height of Site and Curvature.
*c	30	Tables of Logarithms of Trigonometric Functions Computed for Degrees and Hundredths of Degree.
*	31	Searchlights.
	32	Searchlights.
	33	Location and Repair of Faults in Submarine Mine Cable.
	34	Schloming Film-Scale.
	35	A Method of Filling Projectiles.
	36	The Weekly Mine Command Inspection.
	37	Joint Naval and Coast Defense Exercises, August 3-9, 1913.
	38	Analysis of Target Practice.
	39	Gasoline Engines in Distribution Box Boats and Mine Yawls.

* Out of print.
† Obsolete.
a Included in Coast Artillery Drill Regulations.
b Superseded by Weaver's "Notes on Military Explosives."
c Not to be reprinted, as such tables can be purchased commercially.